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Drug Information Systems

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INTRODUCTION

All those with an interest in the pharmaceutical sciences need up-to-date and reliable drug information, not only for their own research and studies, but also for communicating with their healthcare colleagues and patients. In this chapter, we will discuss the wide range of modern electronic drug information systems that are currently available, and will give an indication of their main uses and individual strengths.

Since the 1960s, there has been a dramatic increase in the amount of drug information. The number of chemical compounds alone is growing at a tremendous rate. The CAS Registry database adds around 4000 new substances every day. In tandem with this huge growth of information, there have been many developments in data storage and communication technology, which have impacted on the type of medium used to contain and deliver drug information. Along the way we have used, and are still using, paper, microfilm/microfiche, magnetic tape, floppy disks, CD-ROMs, DVDs, and of course Internet servers. There has been a veritable explosion of drug information on the World Wide Web during the past few years.

Also, there are other features and peculiarities about the nature of drug information (apart from the sheer quantity) which can make it difficult to find what you need. Drugs have several names, and those names can differ from country to country: for example, the substance known as acetaminophen in the United States is known as paracetamol in the UK. Then, there is the problem of licensing arrangements which also differ from country to country: a well-known recent example of this being Viagra, which was available in the United States several months before it officially became available in the UK. (For help with nomenclature try the CAS Registry File, the Merck Index, Martindale, or Pharmaprojects. The last resource is very useful for finding out brand names and gives information on when a product was licensed in different countries.)

BACKGROUND

The sources of drug information are extremely diverse and include journals, books, conference proceedings, patents, and trade literature. These sources are generally classified as primary, secondary, or reference compendia/tertiary information. "Primary" refers to original and new information and "secondary" refers to reviews and commentaries of the primary information, whereas "reference compendia" or "tertiary" usually refers to compilations such as dictionaries and pharmacopoeias. When conducting an information literature search, it is wisest to begin with the reference/tertiary sources as necessary and then move on to the secondary and finally the primary sources of drug information.

REFERENCE COMPENDIA

Pharmacopoeias, Compendia, and Formularies

Many queries can be answered quickly by using a pharmacopoeia, a drug compendium or a formulary. Many of these are now available electronically:

Pharmacopoeias

- United States Pharmacopeia/National Formulary (http://www.usp.org)
- British Pharmacopoeia (http://www.pharmacopoeia.org.uk)
- The European Pharmacopoeia (http://www.pheur.org)

Drug compendia

- Merck Index (http://www.merck.com/pubs)
- Physicians' Desk Reference (http://pdrbookstore.com)
- Martindale: the extra pharmacopoeia (http://www.pharmpress.com)
- DRUGDEX (http://www.micromedex.com/products/drugdex)
- Medicines Compendia (http://emc.vhn.net)
- Pharmaprojects (http://www.pharmaprojects.co.uk)

Formularies

- USP DI, Volume III, Approved Drug Products and Legal Requirements (http://www.usp.org)
- BNF (http://www.bnf.org)

DOI: 10.1081/E-EPT 120011982

SECONDARY SOURCES: INDEXING AND ABSTRACTING SERVICES

Journals are usually the most up-to-date form of primary and secondary scientific literature and the number of new biomedical journals has grown rapidly. Computerized abstracting and information databases are often the first port of call to gain access to the published journal literature on a particular drug topic. There has been a plethora of new drug information system products in recent years but perhaps the most useful, with an international outlook, are MEDLINE, EMBASE, IPA, CAplus, and BIOSIS Previews. These databases are traditionally classed as indexing and abstracting resources and, traditionally enough, started life as paper-based services, although it should be noted that one of the great advantages of their electronic versions is that it is possible with some of them to link directly to the full text of a journal article on screen.

MEDLINE

Produced by the National Library of Medicine in the United States, MEDLINE is the computerized form of Index Medicus, the Index to Dental Literature, and the International Nursing Index dating back to 1966. Over 4600 biomedical journals are indexed from more than 70 countries, although 52% of its current records are from U.S. journals and 75% are derived from English language publications. Updated weekly, 67% of the entries contain abstracts.

When searching for a drug in MEDLINE, it is best to use a generic name. The U.S. Adopted Names are preferred, as the brand name can only be searched for if it is in the title or abstract of the original article. However, since June 1980, the NLM has added other searchable fields to ease drug searching. It is now possible to search on CAS registry numbers, Enzyme Commission Numbers, and the substances of those numbers.

EMBASE

EMBASE is the electronic form of Excerpta Medica, from the publisher Elsevier Science. It contains indexed articles from more than 4000 biomedical journals from 119 countries, although again the English language dominates. EMBASE is stronger on European and Far Eastern literature than MEDLINE. Books were also included from 1975 to 1980. The database goes back to 1974 and is updated weekly.

The generic name, the standard being the WHO International Nonproprietary Name, is the first choice of the EMBASE indexers and for "combination preparations" the brand name is preferred. However, EMBASE allows drugs to be indexed under numerous names, more so than MEDLINE, and even includes the name of the manufacturer if it is in the original article. EMBASE concentrates more on the pharmacological and toxicological aspects of the biomedical literature than MEDLINE.

IPA

International Pharmaceutical Abstracts, available electronically from 1970, from the American Society of Health-System Pharmacists, may only index around 800 journal titles but, as its name suggests, it specializes in pharmacy literature from around the world. A study by Bonnie Snow found that 12% of IPA's journals were not covered by MEDLINE, EMBASE, BIOSIS Previews, or Chemical Abstracts.[1] IPA has also indexed ASHP meetings since 1988, meetings of the American Association of College Pharmacists and the American Pharmacy Association. All records have abstracts.

The preferred index name for a drug is its U.S. Adopted Name. If lab codes and chemical names appear in the same article, lab codes are preferred. When looking for an enzyme, try the CAS Registry Number before the EC Number.

For the literature on dosage forms, drug delivery, pharmacy practice, pharmacy law, cosmetics, pharmaceutical technology, and herbal medicines, IPA is one of the premier resources.

CAplus File

CAS, a division of the American Chemical Society, produces a large number of databases which cover a range of sciences; not only for chemistry, but also for physics, biology, and the applied sciences. CAS's CAplus, developed from Chemical Abstracts, is one of the largest indexing and abstracting databases for chemistry, going back to 1907 and covering over 8000 journals as well as conference proceedings, dissertations, books, and patents from 33 national patent offices. Patents make up 30% of the database. Electronic journals and Web preprints are also included. Updated daily, the literature has worldwide coverage, taking material from 130 countries and from 47, languages.

CAplus is particularly useful to do research for the first stages of drug development. However, it is not so useful for clinical practice. Inevitably, the best way to search for a substance is to use its CAS registry number. It is even possible to draw a chemical structure and conduct a search on it for post-1966 data. Generic and brand names are indexed for searching only if they are provided by the author in the original source.

BIOSIS Previews

From the U.S. BioSciences Information Service, BIOSIS indexes life sciences material from around 5500 journals, theses, conference proceedings, books, and organizational reports. Some U.S. patents were included from 1986 to 1989. The literature is from over 100 countries and from 57 languages. Once again, the English language dominates with 86% of the references being derived from English language sources. BIOSIS goes back to 1969 and is updated weekly. Author abstracts have been given for 55% of references since 1976.

The life sciences remit of BIOSIS means that it covers a wider range of scientific subjects than MEDLINE or EMBASE and has a focus on research rather than clinical practice. As a result, it is good for finding literature on early drug development.

When searching for a drug the U.S. Adopted Name is the first choice, but since 1998 it is also possible to search using CAS registry numbers. Note that it is only possible to search on the fields of brand names, Enzyme Commission Numbers and lab codes if they are given in the original literature source. The indexers at BioSciences Information Service will not add them to the database.

Other pharmaceutical and indexing services which have less of an international remit, but nevertheless have an important place in the drug information armoury include Pharm-line and RPS e-PIC.

Pharm-line

Around 100 English-language pharmacy and medical journals are indexed by pharmacists in UK NHS hospitals. The project is based at the Guy's and St. Thomas's Hospital Trust in London and involves the UK Drug Information Pharmacists' Group. The database, which goes back to 1978 and is updated weekly, is good for pharmacy practice and clinical pharmacy.

RPS e-PIC

Produced by the Royal Pharmaceutical Society of Great Britain e-PIC (electronic Pharmacy Information Coverage) consists of five databases which contain references selected from the major UK pharmacy practice and medical journals since 1992. The databases are e-PIC, which looks at pharmacy practice, New Products, Discontinued Products, Pharmaceutics-Ceuted which covers pharmaceutics, formulation and technology and Pharmacy History.

Criteria/Issues for Selecting an Indexing and Abstracting Service

Searching the secondary literature can be an expensive and time-consuming business, and the intensive marketing of some of the abstracting databases can make objective choice difficult. We have suggested further criteria that could be useful when choosing a database:

1. Subjects covered and the use of descriptors.
2. The fields that are searchable. What information is indexed? For example, can you specify a brand name search?
3. The type of material covered.
4. Geographical coverage.
5. The criteria for items being included.
6. Designated audience.
7. The standing of the service created—is it from a respected institution?
8. Size of the database—the total number of records and the number of journals considered.
9. The years covered.
10. The currency of the service—how often is it updated and what is the time delay between an item being published and it appearing in the database?
11. The inclusion of abstracts.
12. The user friendliness of the interface and the quality of the "Help" screens.
13. The ease of downloading and/or manipulating results.
14. Cost—not just for the database itself but for also for equipment and online costs, if applicable.

It is worth noting that not all of these criteria are linked to the database itself; they may relate to the supplier of the software operating the database. For example, MEDLINE can be purchased from many software vendors, including Ovid and Compact Cambridge. All vendors will provide you with a different user interface and will have varying prices. They will also vary in the timeliness of the latest material on the database, depending on when they update their products from the National Library of Medicine's MEDLINE source data. The NLM also provides its data for free via PubMed (http://www.ncbi.nlm.nih.gov/PubMed) and the NLM Gateway (http://gateway.nlm.nih.gov). As several studies have shown, there are overlaps in coverage between the main indexing and abstracting services, but enough differences to mean that searchers need to use more than one service to gain an accurate picture of the relevant literature.[2,3]

PRIMARY SOURCES

Patent Information

Each country has its own laws for patents, which means it is important to remember that countries differ in the length of protection time given; the name used for the term "patent"; and even about what can be patented. In the United States, patents are sometimes known as "utility patents," but note that some countries provide "utility models" which are similar to patents, but are not as inventive and which also have a shorter protection period. Utility patents are also called "petty patents" (or "Gebrauchsmustern" in German). In the UK, it is neither possible to patent a new plant or animal, nor a method of treatment of the human or animal body by surgery or therapy or a method of diagnosis. However, this is not the case in all countries; e.g., in the United States, plants can be patented.

Patent searching is a specialized field, but there are several useful options for the novice patent searcher. All patent offices will keep indexes of what they have and many of these will be computerized. Chemical Abstracts include patents. A free service on the Web is esp@cenet (http://gb.espacenet.com), which is provided by the European Patent organization. It contains over 30 million worldwide patents going back to 1920, although the past three years are the most comprehensive. For some of these patent applications you can obtain the full text, for others only abstracts or basic bibliographic details. The U.S. Patent and Trade Mark Office Database (http://www.uspto.gov/patft/index.html) gives the full text of patents issued since January 1 1976 and the full-page images of every U.S. patent issued since 1790. The UK Patent Status Information Service (http://webdb4.patent.gov.uk/patents) provides information on the status of a UK patent, e.g., it is possible to see if it is still in force, if you know the Publication or Application Number.

It is worth noting that there is an inevitable overlap between patent and journal literature, as researchers who are registering patents will often be publishing their work in article form throughout a project.[4] One study found that 60% of British pharmaceutical patents had been written about in article form. But of course that still leaves 40% which were not, and in any case the information contained in patents often differs from that given in journal papers.

e-Journals

A growing number of printed journals provide their contents online. Sometimes, this is for free—e.g., the *Pharmaceutical Journal* (http://www.pharmj.com) of the Royal Pharmaceutical Society of Great Britain. But more often than not a subscription is needed. For details of other online pharmacy journals try the Virtual Pharmacy Library, PharmWeb (more information on these is given below in the section *Internet Resources*), and the Free Medical Journals site (http://www.freemedicaljournals.com). Some journals will provide additional information online to their printed versions. *Nature*'s Web site (http://www.nature.com) contains auxiliary data from authors, a link to a grant database and the opportunity to take part in online discussions.

Collections of e-journals, online and CD-ROM, can be purchased so that you can access your own personal "virtual" library from your desktop. One of the largest collections is that from the publisher Elsevier Science, which provides access to over 1000 of its journal titles at ScienceDirect.com. Other collections include the Wiley Interscience and the American Chemical Society. Obviously, many of the titles in these collections will not be directly related to the pharmaceutical sciences, so a careful examination of the journals included is recommended before making a purchasing decision. You may find it more economical to use "pay per view" rather than take out a subscription to the full text of a collection/title.

Electronic only journals were pioneered by American physicists, but now encompass all areas of science. To look at free e-only journals, try the Public Library of Science (http://www.publiclibraryofscience.org) and BioMedNet (http://www.bmn.com). Electronic journals have their advantages: ease of availability in that you no longer have to make a special visit to a Library; they do not take up shelf space, and you no longer need to spend money on binding and binding repairs. For libraries, they have the added advantage of making it easy to gather statistics on usage to help inform acquisition decision-making. However, there are issues/-questions that warrant consideration before moving from print to electronic journal subscriptions, some of which are as follows: Identifying and locating electronic resources can take more time than print.[5] Printed journals are still generally more portable and easier to browse. Continuing access: if you cancel a title, will you still be able to access the issues you paid for? Archiving: will the publisher maintain a permanent archive? (In the UK, at present, there is no legal requirement for electronic/digital material to be placed in a national depository.) Will the publisher be willing to transfer the data to a new medium if the existing technology proves to be transitory? (In the late 1980s, as we all moved away from microfiche, we were told that CDs would last forever, but we have since discovered that their average life-span is from 10 yr to 15 yr). Will the electronic edition of a printed journal be available before or after the print issue? Also, be sure to read the license conditions to check for any restrictive practices: for example, can you download an article rather than print it out?

INTERNET RESOURCES

The Internet, and in particular the World Wide Web, has brought about a huge change to the communication of drug information. Not only has it dramatically increased the amount of information (it has been estimated that the Web contains approximately 800 million pages of information[6] and is doubling in size every year[7]), but it has also enabled the lay person to easily access what in the past would have been "professional only" data. Governments, companies, societies, charities, educational establishments, and individuals are all contributing. It is not just the amount of information that can make the Internet difficult to search, it is also the difficulty in distinguishing between quality material and dubious material that could be downright dangerous. One survey looking at information on Ewing's sarcoma found that 40% of web pages sampled were from nonreviewed resources and, of these, 6% gave incorrect information.[8] There are many more such examples.[9] Of course, it is not just drug information that can be obtained on the Internet, but also the drugs themselves. However, one must keep the dangers of the Internet in perspective.[10] There is a great deal of extremely useful information available, and one should remember that the medium of print can also be abused.[11]

If you need to search the Internet for an unknown site, a good place to start is a pharmacy specific "gateway." This is a Web site which indexes relevant pages. The Argus Clearinghouse (http://www.clearinghouse.net) reviews these gateways (which are sometimes referred to as "virtual libraries" or "internet portals"). Started in 1994, PharmWeb (http://www.pharmweb.net) was one of the first gateways for pharmacy. It indexes sources from across the globe including governments, companies, societies, and pharmacy schools. The U.S. based Virtual Library: pharmacy section (http://www.pharmacy.org) also looks worldwide, but does have a U.S. bias, e.g., the UK's National Health Service is not listed. PharmiWeb (http://www.pharmiweb.com) is designed for UK pharmaceutical industry and provides information on individual companies, employment vacancies, and news. InPharm.com (http://www.inpharm.com) is also aimed at industry, in that it creates web sites for companies to encourage commercial exploitation of the Internet, but it also lists web sites by topic (e.g., new drugs for stroke), and includes directories of those involved in medical communications, along with industry news and vacancies. A site designed by the London and South Eastern Drug Information Service, aimed at health professionals, is called DrugInfoZone (http://www.druginfozone.org). It contains a new section: the latest issues of current awareness bulletins and monthly bibliographic citations from the PharmLine database. Governments are increasingly recognizing the need to steer the rapidly expanding number of Internet users towards quality health sites, and to utilize this source of information and communication to the benefit of both health providers and consumers. The U.S. Healthfinder (http://www.healthfinder.gov) does not just link to government information; it also lists companies, societies, charities, and academic institutions. The Electronic Library for Health (http://www.nelh.nhs.uk) has been designed by the UK government for professionals and the layperson, while NHS Direct (http://www.nhsdirect.nhs.uk) provides patients with information on symptoms, conditions, illness, and disease. The U.S. Food and Drug Administration has its own web site (http://www.fda.gov) but you can also access FDA information on new drugs and recalls at Intelihealth (http://www.intelihealth.com) a site jointly developed by the Harvard Medical School, the University of Pennsylvania and Aetna US Healthcare. Drug information can be searched by generic, brand name, or condition being treated. Although designed for the layperson there is a "professional network" area. Another drug database created for patients and searchable by generic and trade name is MedMaster (http://www.safemedication.com/about/medmaster.cfm) from the American Society of Health-System Pharmacists. This has been developed from the ASHP's *Medication Teaching Manual: The Guide to Patient Drug Information*.

For a list of pharmacy email services, try PharmWeb or the other pharmacy specific gateways discussed earlier.

Once again, much time and energy can be expended on "surfing the net" in the hope of finding relevant, good quality Internet sites providing required drug information. Thus, we have suggested the following guidelines in the hope that they will prove useful.

Criteria/issues for selecting internet resources:

1. Provider/publisher credentials: Are they reputable? A well designed and credible resource will provide an "about us" section, with contact details, and there may also be a site logo. Do you recognize the provider? The URL will also give you a hint as to the origins of an organization, e.g., ac.uk for a British academic institution and .edu for a U.S. educational organization. If any funding sources are listed, would these detrimentally affect the information included?
2. Geographical origin: The "about us" section or the URL should help. All countries, apart from the United States, have a country code for their URLs, although increasingly the domain .com is being used worldwide without any reference to the country of origin. There is also the problem that anyone is free to register a co.uk domain. However, it is another piece of evidence to take into account.

3. Author credentials: Do you recognize the author and/or the organization from which they originate? If you do not, it is worth doing a search on a relevant quality indexing and abstracting service to discover if they have published on the same topic in a reputable journal.
4. Does the author provide references to back up any statements?
5. Currency: Does the site provide a date for when it was last updated?
6. Criteria for information being included. Check the "about us" and "help" sections for this information.
7. Designated audience: If the site is one you want to suggest to your patients, remember it is helpful and a good practice for the site to state that users should visit a health professional if they have any concerns.
8. Awards: Obviously, if a site has won a reputable award it is a positive indication, but make sure you know the credentials of the award. Reputable awards include those from the Health on the Net Foundation (http://www.hon.ch). Their Web site also acts as a gateway to quality medical information.
9. Security: It is worth checking to see if the site has a confidentiality policy, with mechanisms to back it up, if it collects sensitive personal information. Although, of course, one should always remember that no networked computer is totally secure.
10. Speed of access: This can be affected by the providers' and users' hardware, communication technology, and software. Location is also important—Internet sites are always quicker early in the morning providers' local time.
11. Ease of use.
12. Last but not least—price of use, if any.

CONCLUSION

There is little doubt that the already overwhelming quantity of drug information will continue to grow, causing severe problems to those desirous of keeping up-to-date in their field. Additionally, the impact of the Internet explosion has added a further layer of "information overload" to be reckoned with—it is now necessary to search out quality sources of information by the use of gateways and search engines. Indeed (and somewhat ironically) these have developed so quickly and to such an extent that we are now experiencing a difficulty in keeping abreast of the available gateways and portals, let alone the primary information on any topic. New products and packaged services aimed at helping users find drug information are regularly advertised and launched in all professional and scientific fora. Thus, it will become increasingly important for the end user to develop and hone the evaluative skills of critical appraisal to enable him or her to choose good quality and relevant sources of drug information. Finally, it is hoped that readers will remember that experienced drug information scientists and pharmaceutical librarians are there to help with the quest.

REFERENCES

1. Snow, B. Online Database Coverage of Pharmaceutical Journals. Database **1984**, *7*, 12–26.
2. Fishman, L.; Stone, V.L.; DiPaula, B.A. Where Should the Pharmacy Researcher Look First? Comparing International Pharmaceutical Abstracts and MEDLINE. Bull. Med. Libr. Assoc. **1996**, *84* (3), 402–408.
3. Brown, C.M. The Benefits of Searching EMBASE Versus MEDLINE for Pharmaceutical Information. Online and CD-ROM Rev. **1998**, *22* (1), 3–8.
4. Eisenschitz, T. Intellectual Property. In *Information Sources in Pharmaceuticals*; Pickering, W.R., Ed.; Bowker-Saur, 1990; 144–170.
5. Tenopir, C.; King, D.W. The Use and Value of Scientific Journals: Past, Present and Future. Serials **2001**, *14* (2), 113–120.
6. Lawrence, S.; Giles, C.L. Accessibility of Information on the Web. Nature **1999**, *400* (6740), 107–109.
7. Bradley, P. *The Advanced Internet Searchers Handbook*; Library Association Publishing: London, 1999.
8. Biermann, J.S.; Golladay, G.J.; Greenfield, M.L.V.H.; Baker, L.H. Evaluation of Cancer Information on the Internet. Cancer **1999**, *86* (3), 381–390.
9. Purcell, G.P.; Wilson, P.; Delamothe The Quality of Health Information on the Internet: As for Any Other Medium it Varies Widely; Regulation Is Not the Answer. BMJ **2002**, *324* (7337), 557–558.
10. Smith, R. Almost No Evidence Exists That the Internet Harms Health. BMJ **2001**, *323* (7314), 651.
11. Shepperd, S.; Charnock, D. Against Internet Exceptionalism: There's Nothing Radically Different About Information on the Web. BMJ **2002**, *324* (7337), 556–557.

FURTHER READING

Bowman, L.A.; Adams, M.S.; Christopher, A. Information Resources in Pharmacy and the Pharmaceutical Sciences. *In Remington: The Science and Practice of Pharmacy*, 20th Ed.; Gennaro, A.R., Eds.; Lippincott Williams & Wilkins: Baltimore, 2000; 60–69.

Judd, A. *UK Drug Information Manual*, 4th Ed.; UKDIPG: Leeds, 1997.

Newton, D. *How to Find Information: Patents on the Internet*; British Library: London, 2000.

Snow, Bonnie. *Drug Information: A Guide to Current Resources*, 2nd Ed.; Medical Library Association: Scarecrow, 1999.